Description

Transformer Circuit Arrangement

Background of the Invention

The invention relates to a transformer circuit arrangement which is designed, in particular, for the transmission of signals in message transmission systems or communication systems, such as, for example, xDSL systems.

The devices referred to as transformers in message transmission systems are essential passive electrical components which fulfil a wide variety of tasks such as, for example, electrical decoupling, the transforming of voltages/currents, or the changing of impedance values. Due to their large spatial requirements, their high price in comparison with other passive components, their non-linear behaviour, their losses, and the absence of integration capability, the use of such transformers is, however, to be avoided as far as possible. In many cases, it has not hitherto been possible for the transformer to be replaced by a device of equal value, with the result that it cannot be done away with.

In xDSL systems ("Digital Subscriber Line"), for example, the transformer determines the performance capacity of these systems. What is required is a high degree of linearity of the transformer over the entire transmission range, with, at the same time, minimum manufacturing costs. These two requirements are, however, difficult to fulfil simultaneously. In practice, the actual properties of a transformer therefore derive from a compromise, which is to be decided on according to the particular application situation.

An additional problem is incurred by the bandwidth of the

space remains for the equipping of as many channels as possible.

Brief Summary of the Invention

The object of the invention is to provide an economical transformer circuit arrangement with which signals can be transmitted with a large frequency bandwidth and with high linearity.

This object is achieved by a transformer circuit arrangement according to Claim 1. Subclaims refer to preferred embodiments.

The transformer circuit arrangement according to the invention has a first transformer with at least two inputs or input connections respectively, and two outputs or output connections respectively, and a first frequency response with a first lower limit frequency and a first upper limit frequency, as well as a second transformer with at least two inputs or input connections respectively, and two outputs or output connections respectively, and a second frequency response with a second lower limit frequency and a second upper limit frequency. The first lower limit frequency is smaller than the second lower limit frequency, and the second upper limit frequency is greater than the first upper limit frequency. In addition, the second lower limit frequency is preferably not greater or smaller by a factor of 10 than the first upper limit frequency. The transformer circuit arrangement according to the invention has a frequency behaviour with bandpass character with a lower overall limit frequency and an upper overall limit frequency. In this situation, the lower overall limit frequency is smaller than the first upper limit frequency of the first transformer and the second lower limit frequency of the second transformer, and the upper overall limit frequency is greater than the second lower limit frequency of the second transformer and the first upper limit frequency of the first transformer.

The transformer circuit arrangement according to the invention is designed in particular for the transmission of signals in message transmission systems, such as, for example, xDSL systems. With this, one large signal bandwidth or several smaller different bandwidths can be transmitted, in multiplex format, in an economical manner. Thanks to the use of two economically priced transformers of small bandwidth, an even more economical and space-saving device or circuit arrangement can be created for the transmission of signals with, simultaneously, large bandwidth and high linearity, which in overall terms behaves like one individual transformer, as a result of which a switchover in terms of software between different signal frequency ranges is possible. An electronic or electromechanical switchover, and the use of component fitting variants, are not necessary.

With the transformer circuit arrangement according to the invention, it is therefore possible for systems to be created with a large bandwidth dynamic. It is conceivable, for example, for an xDSL Multistandard line card to be created, with which SHDSL signals can be transmitted in the frequency range from, for example, 5 kHz to 500 kHz, and VDSL signals ("Very High Speed Digital Subscriber Line") in the frequency range from 500 kHz to 10 MHz in frequency multiplex. In this situation, the first upper 6 dB limit frequency of the first transformer and the second lower 6dB limit frequency of the second transformer can lie at 500 kHz. There are, however, also applications conceivable in systems with a single large signal bandwidth in the order of, for example, 5 kHz to 10 MHz.

Brief Description of the Drawings

Advantageous embodiments of the invention are explained in greater detail hereinafter on the basis of the drawings. These show:

Fig. 1 A first equivalent circuit diagram of a first transformer (left) and a first equivalent circuit diagram of a second transformer (right),

Fig. 2 An equivalent circuit diagram of a transformer circuit arrangement according to a first embodiment according to the invention,

Fig. 3 The individual insertion loss of the first transformer and of the second transformer of Fig. 2 as a function of the signal frequency (Fig. 3a), the insertion loss of the transformer circuit arrangement according to the invention represented in Fig. 2, as a function of the signal frequency (Fig. 3b) and of the corresponding phase response corresponding to Fig. 3b (Fig. 3c),

Fig. 4 An equivalent circuit diagram of a transformer circuit arrangement according to a second embodiment according to the invention,

Fig. 5 A detailed equivalent circuit diagram of the first or second transformer,

Fig. 6 The individual insertion loss of the first transformer and of the second transformer as a function of the signal frequency (Fig. 6a), the insertion loss of the connection of the two transformers as a function of the signal frequency (Fig. 6b), the phase response corresponding to Fig. 6b (Fig. 6c), and the corresponding active return loss as a function of the signal frequency (Fig. 6d) according to the equivalent circuit diagram from Fig. 5, and

Fig. 7 A schematic circuit diagram of a third embodiment according to the invention of a transformer circuit arrangement.

Detailed Description of the Drawings JP

Fig. 1 shows simple linear equivalent circuit diagrams of a first transformer 101 (left) and a second transformer 102 (right). The first transformer 101 has a series inductance 111, Ls1 (scatter inductance) as well as, in each case, two